STANDARD SPECIAL PROVISIONS

(Metric Units)

DATE: September 26, 2003

The 1995 *Standard Specifications for Highways and Bridges* and the *Supplemental Specifications dated December 11, 2002* are amended by the following modifications, additions and deletions. These are standard special provisions and they shall prevail over those published in the Standard Specifications and the Supplemental Specifications.

The Specifications Committee has issued these Standard Special Provisions for inclusion into each project until such time as they are approved as Standard Specifications by the Board of Commissioners.

Contractors are cautioned that these Standard Special Provisions are constantly being updated and may vary from project to project.

DIVISION I
GENERAL REQUIREMENTS AND COVENANTS

SECTION 7.00
LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

SUBSECTION 7.15 Claims Against Contractors for Payment of Labor, Materials and Other Purposes.
(page I.39) Delete from the second paragraph through the end of this Subsection:

SECTION 8.00
PROSECUTION AND PROGRESS

SUBSECTION 8.07 Character of Workmen, Methods and Equipment.
(pages I.50) In the second paragraph from the end of this Subsection replace "… by the Contractor is accomplishing…" with "… by the Contractor in accomplishing…".

DIVISION II
CONSTRUCTION DETAILS

SECTION 120
EXCAVATION

SUBSECTION 120.20 General.
(page II.10) Add the following to the end of this Subsection:

Existing concrete foundations, if not interfering with the proposed construction, may be abandoned in place with approval of the Engineer. Foundations under the roadway surface shall be removed to a depth of 1 meter below finished grade. Foundations outside of the roadway surface shall be removed to a depth of 300 millimeters below the proposed finished grade.

SECTION 140
EXCAVATION FOR STRUCTURES

SUBSECTION 140.80 General.
(page II.20) In the second full paragraph of the page, replace the word 'scope' with 'slope' in the third sentence and replace 'be1' with 'be 1' in the fourth sentence.

SECTION 150
EMBANKMENT

SUBSECTION 150.64 Backfilling for Structures and Pipes.
(page II.28) Replace the second paragraph under C. Pipes with the following:

Material used for backfilling to a point 600 millimeters over the pipe shall contain no stones larger than 75 millimeters in greatest dimension, except material used to backfill corrugated plastic pipe shall consist of gravel borrow meeting the requirements of M1.03, Gravel Borrow Type d to a depth of 600 millimeters over the top of pipe.

(page II.28) Delete the fourth paragraph under C. Pipes.

SUBSECTION 150.66 Gravel Borrow for Bridge Foundations.
(page II.29) Replace the last sentence of the second paragraph with the following:

If the material retained on the 19.0 millimeter sieve is more than 30% of the total sample the test results from AASHTO T 180 shall be corrected in accordance with AASHTO T 224.

SECTION 230
CULVERTS, STORMDRAINS AND SEWER PIPES

SUBSECTION 230.40 Materials.
(page II.49) Add the following:

Corrugated Plastic Flared Ends	M5.03.10

SUBSECTION 230.81 Basis of Payment.
(page II.51) Add the following to the first paragraph:

Corrugated plastic pipe shall include gravel borrow type d backfill material.

SUBSECTION 230.82 Payment Items.
(page II.51) Delete payment item 233 Cement Concrete Pipe and add the following:

*252.1-	-Millimeter Corrugated Plastic Pipe Flared End	Each

SECTION 460
HOT MIX ASPHALT PAVEMENT

SUBSECTION 460.63 Spreading and Finishing.
(page II.82) Replace the 5th, 6th, and 7th paragraph from the bottom with the following:

Hot mix asphalt shall not be placed after November 15 or before April 1 without the written permission of the Engineer.

When the air temperature falls below 10◦C, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, placing, and compacting the mixtures.

No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled to 75◦C, and provided that the density of the completed pavement attains at least 95% of the laboratory compacted density.

No mix shall be placed on wet or damp surfaces.

OGFC mixtures shall only be placed when both the surface and ambient temperatures are at least 10°C and rising when measured in the shade and away from artificial heat. Regardless of any temperature requirements, OGFC mixtures shall not be placed after October 31 or before May 1 without the written permission of the Engineer.

SUBSECTION 460.64 Compaction.
(page II.84) Add the following paragraph after the 6th paragraph on the page:

For Open Graded Friction Course, OGFC, initial rolling may be accomplished with the breakdown roller within a short distance of the paver, allowing earlier compaction. Any subsequent rolling shall be adjusted in order not to over-roll the mixture. No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled to 90◦C. Vibratory rollers or rubber tire rollers will NOT be permitted on OGFC mixtures.

SECTION 601
HIGHWAY GUARD

SUBSECTION 601.40 General.
(page SUPPLEMENT2002-21) Replace this Subsection with the following:

Materials shall meet the requirements specified in the following Subsection of Division III, Materials:

Steel Beam Highway Guard	M8.07.0
Steel Beam Highway Guard End Treatments	M8.07.1

The Contractor shall provide the Engineer with copies of the Manufacturer's documentation including installation drawings for all guard rail components and end treatments indicating acceptance by the Federal Highway Administration as meeting the requirements of NCHRP Report 350, Test Level 3, for the conditions at the intended location.

The contractor shall provide a detailed list of all of the system components for maintenance purposes. No work shall commence under these items until the Engineer has received all documentation.

SECTION 840
SIGN SUPPORTS

SUBSECTION 840.81 Basis of Payment.
(page II.220) Replace this Subsection with the following:

Payment items in the 841. payment item series, and payment items 845.1 through 848.1 shall be paid at the contract unit price for each sign installed. Payment for work done under payment items 840.1* and items 842.1* to 844.1 shall be at the contract lump sum price.

The contract price shall be full compensation for designing, furnishing and erecting the supports, including construction of the concrete bases, steel reinforcement and anchor bolts; furnishing and installing post assembly and all excavation, gravel backfill and compaction except rock excavation, which shall be paid under Class B Rock Excavation.

SUBSECTION 840.82 Payment Items.
(page II.221) Replace this Subsection with the following:

840.1*	Support for Overhead Guide Sign (OD-*) Steel	Lump Sum
841.1	Support for Guide Sign (D6 with D8 – 125 mm Tubular Post) Steel	Each
841.2	Support for Guide Sign (D6 – 125 mm tubular Post) Steel	Each
841.3	Support for Guide Sign (D6 – P5 Posts) Steel	Each
841.4	Support for Guide Sign (D8 – 100 mm Tubular Post) Steel	Each
841.5	Support for Guide Sign (D8 – P5 Posts) Steel	Each
841.6	Support for Guide Sign (I-2A – 125 mm Tubular Post) Steel	Each
841.7	Support for Guide Sign (D6 with D8 – Special Design) Steel	Each
841.8	Support for Guide Sign (D6 – Special Design) Steel	Each
842.1*	Support for Guide Sign (GF-*) Steel	Lump Sum
844.1*	Support for Guide Sign (G*) Steel	Lump Sum
845.1	Support for Guide Sign (E5-1) Steel	Each
846.1	Supports for Guide Sign (E5-1A) Steel	Each
847.1	Sign Support (Not Guide) and Route Marker with 1 Breakaway Post Assembly - Steel	Each
848.1	Sign Support (Not Guide) and Route Marker with 2 Breakaway Post Assemblies - Steel	Each
144.	Class B Rock Excavation	Cubic Meter

* = as per MHD Standard Nomenclature

SECTION 850
TRAFFIC CONTROLS FOR CONSTRUCTION AND MAINTENANCE OPERATIONS

SUBSECTION 850.21 Safety Controls for Construction Operations.
(page SUPPLEMENT 2002-38 and 39) Replace the existing Subsection with the following:

Safety Controls for Construction Operations consists of furnishing, positioning, repositioning, maintaining and removing, as needed and/or as directed: traffic cones, warning devices, special apparel, etc. high level warning devices, delineators, floodlights, Type I and II barricades, portable flashing and steady burning lights, hand signal devices, lanterns, and pilot cars.

The work consists of providing daily lane closures for purposes of safely directing traffic, by approved methods, away from and/or through areas affected by the contractor's operations. The work shall be done in accordance with the Traffic Management Plan or as directed by the Engineer. This item does not include those specific devices for which payment is made under other contract items.

SUBSECTION 850.80 Method of Measurement.
(page SUPPLEMENT 2002-39) Replace the new Supplemental paragraph at the start of this Subsection with the following:

Safety controls for construction operations will be measured by the unit day. Each eight hour period for which safety controls are in place will be measured as one unit day, regardless of the number of times that traffic control devices are positioned, repositioned, or removed. Periods of duration other than eight hours will be measured by the quantity of unit days, equal to the actual number of hours in that period divided by eight hours for each unit day. No measurement will be made for periods during which traffic controls are left in place for reasons other than construction activity.

SUBSECTION 850.81 Basis of Payment.
(page SUPPLEMENT 2002-39) Replace the second paragraph with the following:

The contract unit price for Safety Controls for Construction Operations will include full compensation for furnishing, positioning, repositioning, and removing traffic control devices as directed by the engineer.

SECTION 930
PRESTRESSED CONCRETE BEAMS

SUBSECTION 930.82 Payment Items.
(page II.256) Replace this Subsection with the following:

930.*	Prestressed Concrete Deck Beam (S*)	Meter
930.1*	Prestressed Concrete Box Beam (B*)	Meter
930.2*	High Performance Prestressed Concrete Box Beam (B*)	Meter
931.*	Prestressed Concrete Bulb-Tee Beam (NEBT*)	Meter
931.1*	High Performance Prestressed Concrete Bulb-Tee Beam (NEBT*)	Meter
932.	Elastomeric Bridge Bearing Pad	Square Meter
933.	Elastomeric Bridge Bearing Pad	Each

* = as per MHD Standard Nomenclature.

SECTION 945 Drilled Shafts.
(page II.271) Add this Section.

SECTION 945
DRILLED SHAFTS

DESCRIPTION

945.20 General.

This work shall consist of excavating and constructing drilled, cast-in-place reinforced concrete shafts installed in accordance with these specifications and the details and dimensions shown on the plans.

Drilled shafts shall consist of reinforced concrete sections that are cast-in-place against in situ soil or rock or a casing. Permanent casings are designed as part of the drilled shaft and shall remain in place after concrete placement is completed. Temporary casings shall be installed to facilitate drilled shaft construction and removed during or after concrete placement. The embedment length of the drilled shafts may be modified by the Engineer, pending results of any subsurface investigation taken and/or load testing performed as an initial part of the work, as approved by the Engineer.

MATERIALS

945.40 Materials.

Materials shall meet the requirements specified in the following Subsections of Division III, Materials:

Cement Concrete	M4.02.00
Reinforcing Steel	M8.01.0
Epoxy Coated Reinforcing Bars	M8.01.7
Galvanized Reinforcing Bars	M8.01.8
Mechanical Reinforcing Bar Splicer	M8.01.9
Steel Casings	M8.05.8
Cross Hole Sonic Testing Access Pipes	M8.22.0
Drilling Slurry	M9.40.0

CONSTRUCTION METHODS

945.50 Personnel Qualifications.

Drilled shaft construction personnel must be experienced in this type of work. Experience shall be relevant to anticipated subsurface materials, water conditions, shaft size, and special construction techniques required. Prior to the Preconstruction Conference, the Contractor shall submit the following information to verify the firm's experience and the qualifications of personnel scheduled to perform the drilled shaft construction:

1. Submit a list of at least three projects successfully completed in the last five years, which used drilled shaft construction. Include a brief description and reference for each project listed.
2. Provide the names and detail the experience of the on-site supervisors and drill operators for the Project. On-site supervisors shall have at least two years of experience in drilled shaft construction, and drill operators shall have at least one year of experience.
3. A signed statement that the Contractor has inspected both the project site and all the subsurface information including any soil or rock samples made available in the contract documents.

SECTION 945 (continued)

Work on any drilled shafts shall not begin until the qualifications have been approved. The Engineer may suspend the drilled shaft construction if the Contractor substitutes unapproved personnel during construction. Requests for substitution of field personnel shall be submitted to the Engineer for approval. Additional costs resulting from the suspension of work will be the Contractor's responsibility, and no extension in contract completion date resulting from the suspension of work will be allowed.

The Contractor shall have on site during all drilled shaft construction activity a minimum of one certified Field Inspector. The Field Inspector will be responsible for Quality Control (QC) of the drilled shafts during all phases of construction, and will monitor and document all QC inspection and testing activities required by the specifications and outlined in the Contractor's Drilled Shaft Installation Plan. Field Inspectors shall be certified as a Drilled Shafts Inspector by the New England Transportation Technician Certification Program (NETTCP).

945.51 Drilled Shaft Installation Plan.

The Contractor shall submit an installation plan for review and approval of the Engineer at least 30 days prior to the anticipated date of beginning drilled shaft work. This plan shall provide the following:

1. The sequence of drilled shaft construction as it relates to the overall construction plan and the sequence of shaft construction in bents or groups.
2. A review of equipment suitability based on the Contractor's understanding of the site subsurface conditions. Include a project history of the drilling equipment that demonstrates the successful use of the equipment for drilled shafts of equal or greater size in similar subsurface conditions. List proposed equipment with manufacturer's specification and catalog data including cranes, drills, augers, bailing buckets, casing oscillators, casing twisters, vibratory hammers, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casing, etc.
3. Details of shaft excavation methods in soils and rock, including sloping bedrock and methods of removing any obstructions such as boulders or foundations, including a disposal plan for excavated material. Include details of methods used to perform final cleaning of the excavation and checking the cleanliness and soundness of the rock socket sidewalls and bearing surface.
4. Include details of the methods and materials used to fill or eliminate all voids between the plan shaft diameter and excavated shaft diameter, or between the casing and surrounding soil, if permanent casing is specified. Include a disposal plan for any water or contaminated concrete expelled from the top of the shaft (if applicable).
5. Details of the proposed method(s) for ensuring drilled shaft stability during excavation and concrete placement.
6. Method of monitoring plumbness and location of the shaft during construction.
7. Details for the use of drilling slurry including methods to mix, circulate, de-sand, maintain and dispose of the slurry (if applicable). Include a discussion of the suitability of the proposed drilling slurry in relation to the anticipated subsurface conditions.
8. A plan for quality control of drilling slurries, if their use is proposed. In the quality control plan, include property requirements, required tests and test methods to ensure the synthetic slurry performs as intended. Submit to the Engineer the name and current phone number of the synthetic slurry manufacturer's representative who will provide technical assistance during construction.
9. Reinforcing steel shop drawings and details of reinforcement placement, including bracing, centering and lifting methods and the method for supporting the reinforcement on the bottom of the shaft excavation. Include details for ensuring the reinforcing cage position is maintained during construction. Include details for attaching the crosshole sonic logging test access tubes to the reinforcing cage.
10. Evidence that the proposed materials and concrete mix design conform to all applicable Specifications.

SECTION 945 (continued)

11. Details of concrete placement, including proposed operational procedures for pumping and/or tremie methods and methods of curing and protecting the concrete. Include details for grout placement in the crosshole sonic logging test access tubes after testing is completed (if applicable).
12. Detailed procedures for permanent casing installation and temporary casing installation and removal, including casing dimensions.
13. Two copies of “Drilled Shaft Inspector's Manual” (latest edition), available from International Association of foundation Drilling (ADSC) at www.adsc-iafd.com and the Deep Foundation Institute (DFI) at www.dfi.org, shall be supplied to the Resident Engineer. These manuals shall become the property of the Department.

The Engineer shall approve or reject the drilled shaft installation plan after receipt of all submissions. The Contractor shall provide any additional information and submit a revised plan, if requested, for review and approval. All procedural approvals given by the Engineer will be subject to trial in the field and will not relieve the Contractor of the responsibility to satisfactorily complete the work. The Contractor shall submit requests for modification of adopted procedures to the Engineer.

All portions of proposed construction shall be described on shop drawings and submitted to the Engineer for approval. No work shall commence prior to receiving the written approval of the proposed methods and equipment by the Engineer. This approval shall be considered in no way as relieving the Contractor of the responsibility to satisfactorily complete the work in accordance with the Plans and Specifications.

A Preconstruction Meeting shall be conducted when so requested by the Engineer. Such meeting is held among the Department, the Contractor and the Drilled Shaft Subcontractor to review special requirements for the drilled shaft work, including installation plans, acceptance and rejection criteria, and project documentation.

945.52 Borings.

When required in the contract documents, soil borings and/or rock cores shall be conducted at the specified locations and to the indicated size and depth, as approved by the Engineer. The boring logs shall be reviewed by the Contractor and shall be submitted to the Engineer for approval prior to mobilizing drilled shaft equipment. All work shall be performed in accordance with Section 190, Borings.

945.53 Trial Drilled Shaft.

When required in the contract documents, a trial shaft shall be constructed by the Contractor. A trial shaft may be required on projects where unusual and variable subsurface conditions exist, when the dry method of construction is proposed, and/or when excavations are performed in open water areas.

The Contractor shall demonstrate the adequacy of his methods, techniques and equipment by successfully constructing a trial shaft in accordance with the plans and these requirements. This trial shaft shall be drilled to the maximum depth of any production shaft and away from production shafts as shown on the plans or as directed by the Engineer. Failure by the Contractor to demonstrate the adequacy of methods and equipment shall be reason for the Engineer to require modifications in equipment and/or method by the Contractor to eliminate unsatisfactory results. Any additional trial holes required to demonstrate the adequacy of altered methods or equipment shall be at the Contractor’s expense. The same methods and equipment used to construct the approved trial shaft shall be used to construct the production shafts.

Unless otherwise indicated, the trial shaft holes shall be filled with unreinforced concrete in the same manner that production shafts will be constructed and shall be cut off 610 millimeters (2 feet) below finished grade and left in place. The disturbed areas at these shafts shall be restored as nearly as practical to their original condition.

SECTION 945 (continued)

945.54 Protection of Existing Structures.

The Contractor shall control his operations to prevent damage to existing structures and utilities. Preventive measures shall include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, monitoring and controlling the vibrations from construction activities such as the driving of casing or sheeting, drilling of the shaft, or from blasting, if permitted. The Contractor shall be responsible for selecting and using equipment and procedures that keep deformations of adjacent structures within acceptable levels as determined by the Engineer.

945.55 General Methods and Equipment.

The Contractor's methods and equipment shall have adequate capacity including power, torque and down thrust to excavate a hole of both the maximum diameter and to a depth of 25% beyond the depths shown on the plans. The permanent casing method shall be used only at locations shown on the plans or when authorized in writing by the Engineer. The Contractor shall provide all equipment and tools as necessary to construct the shaft excavation to the size and depth required. Drilling tools should contain vents to stabilize hydrostatic pressure above and below the tool during insertion and extraction.

A. Dry Method.

The dry method shall be used only at sites where conditions are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft can be visually inspected by the Engineer during the excavation and prior to placing the concrete. The dry method shall only be approved when a trial shaft excavation demonstrates that: less than 152 millimeters (6 inches) of water accumulates above the base over a one-hour period without pumping; the sides and bottom of the hole remain stable without caving and sloughing over a four-hour period following completion of excavation; any loose material or water can be removed prior to inspection and concrete placement.

B. Wet Method.

The wet method consists of using water or slurry (mineral or polymer) to maintain stability of the drilled hole while advancing the excavation to final depth, placing the reinforcing cage, and concreting the shaft.

Slurry should be introduced when the depth of the drilled hole is still above the piezometric level and not after the inflow of water is detected and/or sloughing has begun. This method may involve desanding and cleaning the slurry and final cleaning of the excavation by means of bailing bucket, air lift, submersible pump or other approved devices.

The wet method may also be used in combination with the casing method.

C. Casing Construction Method.

The casing method may be used at sites where the dry or wet methods are inadequate to prevent hole caving or excessive deformation of the hole. The casing may be either placed in a predrilled hole or advanced through the ground by twisting, driving, or vibration before being cleaned out. When the casing is placed in a predrilled borehole, the temporary stability of the hole may need to be assured by using drilling slurry. The rising column of fluid concrete must force the slurry that is trapped in the annular space behind the casing out as the casing is being pulled.

The casing method may not be permitted at specified depths that are designated for mobilization of side resistance.

945.56 Drilled Shaft Excavation.

A. General.

The Contractor shall use excavation techniques that are technically adequate and cost effective to meet the geologic conditions encountered at the site. Excavation for drilled shafts shall be made so that the sidewalls of the hole are stable at all times.

SECTION 945 (continued)

Drilled shafts shall be excavated to the dimensions and elevations shown or as directed. Materials removed from the shaft excavations and slurry shall be disposed of according to the applicable federal, state and local regulations and shall not be discharged into any stream, waterway, or storm water drainage system.

If approved by the Engineer, a partially excavated shaft may be left open overnight, provided that the excavation:

- Is stabilized at the bottom, sides and surface to prevent soil caving or swelling or a reduction of soil strength, and
- Is covered at the surface to protect the public.

Excavation shall not commence immediately adjacent to a concreted drilled shaft for a minimum of 24 hours after completing the shaft concrete pour.

The Contractor shall extend the drilled shaft tip elevations when so indicated by the results of the load test and/or the Engineer determines that the material encountered during excavation is unsuitable or differs from that anticipated in the design of the drilled shaft.

Drilled shaft excavation is excavation accomplished with conventional tools such as earth augers, casing twisters, drilling buckets, and overreaming (belling) buckets attached to drilling equipment of the size, power, torque, and down thrust (crowd) approved for use by the Engineer.

Should the Engineer have reason to believe that the drilled shaft excavation techniques or workmanship have been deficient, so that the integrity of any excavation is in question, work on that drilled shaft shall be stopped. Drilled shaft excavation will not be allowed to resume until the deficient excavation techniques or workmanship have been changed to the satisfaction of the Engineer.

B. Clean Out.

Appropriate means, such as a cleanout bucket or air lift, shall be employed to clean the bottom of the drilled shaft excavations. No more than 25 millimeters (1 inch) of loose or disturbed material will be allowed at the bottom of the excavation for end-bearing drilled shafts. No more than 75 millimeters (3 inches) of loose or disturbed material will be allowed at the bottom of the excavation for skin friction drilled shafts. All drilled shafts shall be assumed to be end-bearing shafts unless otherwise shown or specified. Shaft cleanliness will be determined by the Engineer.

The Engineer shall be notified of completion of each drilled shaft excavation to permit inspection before proceeding with construction.

The drilled shaft dimensions and alignment shall be verified with approved methods. Final shaft depths shall be measured with a suitable weighted tape or other approved method after final cleaning. The drilled shaft excavation may be extended if the Engineer determines that the subsurface materials encountered are not capable of providing the required bearing capacity or differ from those anticipated in the design of the drilled shafts.

If caving occurs during any construction procedure, the construction operation shall be stopped, the Engineer shall be notified, and the shaft excavation shall be stabilized by approved methods.

C. Rock Socket Excavation.

Rock socket excavation is excavation that requires rock-specific tools and/or procedures to accomplish hole advancement, such as rock augers and core barrels. All excavation, performed below the depth where rock socket excavation is authorized shall be considered so regardless of the density, strength, hardness, or changes in type or character of materials encountered.

SECTION 945 (continued)

D. Obstruction Excavation.

Obstructions are defined as impenetrable objects that cannot be removed or excavated using conventional rock or soil augers, drilling buckets, casing twisters, and cause a significant decrease in the rate of excavation advancement as compared to before the obstruction was encountered or shafts in close proximity advanced using the same techniques and equipment. The Engineer will consider the equipment, techniques, and level of effort by the Contractor and shall be the sole judge of the significance of any reduced rate of shaft advancement and the classification of obstruction excavation. Special procedures/tools needed to remove obstructions may include: core barrels, chisels, boulder breakers, downhole hammers, hand excavation, temporary casing, and increasing the hole diameter. Blasting shall not be permitted unless specifically approved in writing by the Engineer. The Contractor shall specifically log the depth and rate of removal of the obstruction.

Those obstructions located within 1.52 meters (5 feet) of the top level of the ground surface during shaft drilling at shaft locations shall be removed at the expense of the Contractor. Such obstructions may include man-made materials such as old foundations, utilities, tunnels, and natural materials such as boulders and wood.

Drilling tools that are lost in the excavation shall not be considered obstructions and shall be promptly removed by the contractor without compensation. All costs due to lost tool removal shall be borne by the Contractor including but not limited to, costs associated with the repair of hole degradation due to removal operations or an excessive time that the hole remains open.

The rate of occurrence of obstruction encounters during the excavation and construction of drilled shafts may vary considerably from what is inferred from the boring logs due to sampling limitations of the boring(s), sampling bias due to the diameter differences between the drilled shaft and the boring(s), and spatial variability of the soil deposit.

The Engineer shall be present to evaluate the occurrence of obstructions, to authorize, and to approve the designation of such. Sloping bedrock and/or higher than anticipated bedrock, as inferred from the borings, shall not be considered obstruction excavation.

E. Casings.

Casings shall be steel, clean, watertight, and of ample strength to withstand handling and installation induced stresses and the pressure from both concrete and surrounding earth materials. The outside diameter (O.D.) of casings shall not be less than the specified size of shaft. Casings may be either placed in a predrilled hole or advanced through the ground by twisting, driving or vibration before being cleaned out.

Permanent casings shall be used only at locations shown on the plans or upon approval by the Engineer. The casing shall be continuous between top and bottom elevations.

Temporary casings shall be provided to aid shaft alignment and position, to prevent sloughing of the shaft excavation, and to prevent excessive deformation around the hole unless the Contractor demonstrates to the satisfaction of the Engineer that the casing is not required.

As the temporary casing is withdrawn, the level of concrete (and drilling fluid/slurry, if used) shall be maintained with a sufficient head to prevent any water and/or other extraneous materials from entering the drilled shaft. In addition to the foregoing, the level of concrete in the temporary casing shall be maintained a minimum of 1.52 meters (5 feet) from the bottom of the casing. As the casing is withdrawn, care shall be exercised to maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the shaft concrete.

SECTION 945 (continued)

F. Drilling Slurry Installation.

If synthetic drilling slurry is selected, a manufacturer's representative shall be available to provide technical assistance at the site prior to use of the slurry. The manufacturer's representative shall remain available during construction to adjust the slurry mix for the specific site subsurface conditions.

All in-hole drilling slurry shall meet the required Specifications prior to concrete placement. The slurry shall be cleaned, re-circulated, de-sanded or replaced to maintain the required slurry properties. The level of slurry in the excavation shall be maintained at not less than 1.52 meters (5 feet) above the groundwater level for all slurries. The slurry level shall be maintained a sufficient distance above all unstable zones to prevent bottom heave, caving or sloughing.

Slurry shall feed continuously into the shaft excavation as drilling progresses so that a stable excavation is maintained. A self-priming pump shall be used to reclaim the slurry. A functioning standby pump shall be kept on-site and available during the drilling operation.

G. Drilling Slurry Inspection and Testing.

All drilling slurries shall be mixed and kept thoroughly hydrated in an appropriate storage facility. Sample sets shall be collected from the storage facility and tests shall be performed to ensure the slurry conforms to the specified material properties before introduction into the drilled shaft excavation. A sample set shall be composed of samples taken at mid-depth and within 610 millimeters (24 inches) of the bottom of the storage facility. All slurry shall be sampled and tested in the presence of the Engineer, unless otherwise directed. Final cleaning of the excavation and placement of concrete will not be allowed until the test results indicate the slurry properties are as specified.

A minimum of two sets of slurry tests shall be performed per eight-hour work shift, the first test being done at the beginning of the shift. Field conditions may require more frequent testing to ensure acceptable slurry properties. Copies of all slurry test results shall be provided to the Engineer on request.

945.57 Construction Quality Control.

A. Location and Survey.

Drilled Shafts shall be located and staked by the Contractor who shall maintain and be responsible of all location and elevation stakes.

The Contractor shall maintain a construction method log during shaft excavation and concreting of each drilled shaft. This record shall be available for the Engineer's inspection as directed. The log shall contain for each shaft the following information:

- Shaft number, date and time of installation.
- Description and approximate top and bottom elevation of each soil or rock material, and final tip elevation.
- Level and variation of the piezometric surface.
- Excavation procedures and method used to stabilize the sides of shaft and any seepage of groundwater.
- Quantity, type of obstruction material, and drilling rate.
- Diameter of the as-built shafts.
- Plumbness and deviation of shaft location.
- Type, diameter, and length of any casing left in place.
- Time, method, and duration of placement of concrete.
- A chart showing quantity of concrete placed versus depth or elevation of top of concrete in shaft during placement.
- Other pertinent data relative to the installation.

SECTION 945 (continued)

B. Construction Sounding.

The Contractor shall provide to the Engineer access and equipment for checking the dimensions and alignment of each permanent shaft excavation. After excavation is complete, the bottom of the shaft shall be measured and sounded with a steel rod (AW) and/or a weighted tape. A check of the bearing surface by sounding shall be made in the presence of the Engineer, who shall determine if the drilled shaft excavation is acceptable. The bearing surface shall be sounded again immediately before placing concrete.

Unless otherwise stated in the plans, no more than 25 millimeters (1 inch) of loose or disturbed material will be allowed at the bottom of the excavation for drilled shafts designated as end-bearing and no more than 75 millimeters (3 inches) of loose or disturbed material will be allowed at the bottom of the excavation for drilled shafts designated as deriving their capacity from skin friction. Shaft cleanliness will be determined by the Engineer, based on visual inspection for dry shafts and other methods deemed appropriate for wet shafts. In addition, for dry excavations the maximum depth of water shall not exceed 75 millimeters (3 inches) prior to concrete placement.

C. Construction Tolerances.

The following construction tolerances apply to drilled shafts unless otherwise stated in the contract documents:

1. The drilled shaft shall be within 75 millimeters (3 inches) of plan position in the horizontal plane at the plan elevation for the top of the shaft.
2. The vertical alignment of a shaft excavation shall not vary from the plan alignment by more than 20 millimeters per meter (1/4 inch per foot) of depth or 2% of plumb for the total length of shaft.
3. After all the concrete is placed, the top of the reinforcing steel cage shall be no more than 150 millimeters (6 inches) above and no more than 75 millimeters (3 inches) below plan position.
4. The top elevation of the shaft shall be within 50 millimeters (2 inches) of the plan top of shaft elevation.
5. The bottom of the shaft excavation shall be perpendicular to the axis of the shaft within 80 millimeters per meter (1 inch per foot) of shaft diameter.
6. When the shaft steel reinforcement is to extend into the structural column or cap, all plan, vertical, and elevation tolerances shall meet the structural column or cap requirements.

Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances are unacceptable. Correction methods shall be submitted by the Contractor for the Engineer's review and approval before continuing with any drilled shaft construction. Correction procedures are dependent on analysis of the effect of the degree of misalignment and improper positioning.

D. Scheduling and Restrictions.

Drilled shaft excavation and cement concrete placement shall be scheduled so that each drilled shaft is cast immediately after drilling operations are complete. After the first drilled shaft on a project has been accepted, no significant change in construction methods, equipment, or materials used shall be made in the construction of subsequent shafts, unless approved by the Engineer. Construction of subsequent shafts shall not proceed until the first drilled shaft has been approved by the Engineer. Drilling may commence on a subsequent shaft at an approved location provided that the cement concrete placement operation on the previous drilled shaft is in progress and there are sufficient workers present to complete all required operations.

For a minimum period of 24 hours after completion of the cement concrete placement operation in a newly constructed shaft, including withdrawal of casing if applicable, none of the following operations shall be permitted within 4.57 meters (15 feet) of the newly constructed shaft:

- Excavation for adjacent shafts;
- Construction of footings;
- Application of equipment loads;
- Introduction of vibrations with a peak particle velocity of greater than 6 millimeters (1/4 inch) per second.

SECTION 945 (continued)

945.58 Steel Reinforcement Configuration and Placement.

Steel reinforcement shall not be placed until the Engineer has approved the results of all borings and load tests for drilled shafts.

The clear spacing between bars of the steel reinforcement cage shall be at least 5 times the size of the maximum coarse aggregate size of concrete. Hooks at the top of the steel reinforcement cage shall not be bent outward if there is any chance that temporary casing will be used. Similarly, interior hooks must be designed to permit adequate clearance for a concrete tremie pipe, i.e., 305 millimeters (12 inches) minimum.

The assembled steel reinforcement cage outside diameter must be at least 250 millimeters (10 inches) smaller than the drilled hole diameter. This clear space is necessary both to permit free flow of concrete up the annular space between the cage and the hole perimeter and to provide adequate concrete cover over the steel reinforcement cage.

The steel reinforcement in the shaft shall be tied and supported so that the steel reinforcement will remain within the allowable tolerances given above. Concrete spacers or other non-corrosive durable spacing devices shall be used at sufficient intervals not exceeding 3 meters (10 feet) up the shaft to insure concentric spacing for the entire steel reinforcement cage length. The spacers shall be of adequate dimension to insure a minimum 125 millimeter (5 inch) annular space between the outside of the steel reinforcement cage and the side of the excavated hole or casing. The spacing of the spirals and/or ties may be adjusted slightly to accommodate the rotation of the centering devices. Cylindrical concrete feet, or approved alternate bottom supports, shall be provided to ensure that the bottom of the cage is maintained 75 millimeters (3 inches) above the base.

The steel reinforcement cage, consisting of longitudinal bars, spirals and/or ties, cage stiffener bars, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted. The steel reinforcement cage shall be supported by positive methods to prevent its displacement during concrete placement.

945.59 Cement Concrete Placement.

A. General.

Cement concrete placement shall be performed in accordance with the applicable portions of Section 901 and in accordance with the requirements herein. Cement concrete quantities over the theoretical amount required to fill any excavations for the shafts dimensioned on the plans shall be furnished at the Contractor's expense.

The bottom of the shaft shall be sounded immediately before placing concrete. Cement concrete placement for a drilled shaft shall start within 2 hours after the excavation has been completed and approved and the steel reinforcement has been placed and approved. If cement concrete placement is not begun within 2 hours, then the steel reinforcement cage shall be removed and inspected. The Contractor shall remove any caked slurry or soil from the steel reinforcement cage before returning the cage to the shaft, re-clean the bottom, re-circulate, and test the slurry prior to resetting cage. Cement concrete shall be placed in a manner to prevent segregation. Cement concrete placement shall be a continuous operation except for the time interval necessary to remove temporary casings, tremie pipe sections, and to change concrete trucks.

The cement concrete shall remain in a workable plastic state through the placement period. Prior to cement concrete placement the Contractor shall provide test results of both a trial mix and slump test conducted by an approved testing laboratory to demonstrate that the cement concrete meets the above requirements.

If the drilled shaft excavation cannot be pumped free of seepage water at the time of cement concrete placement, the cement concrete shall be placed under water with a tremie pipe or pump hose. Cement concrete placement shall proceed continuously from the bottom of the shaft to the top of shaft elevation shown.

Shaft cement concrete may be placed without mechanical vibration in those areas of the drilled shaft that are not formed or are below the ground line or the water surface.

SECTION 945 (continued)

If caving occurs during concrete placement, the shaft will be rejected and a repair plan shall be submitted by the Contractor to the Engineer for approval.

Should a delay in cement concrete placement occur because of a delay in cement concrete delivery or other factors, the placement rate shall be reduced to maintain a flow of fresh concrete into the shaft excavation. A maximum of 60 minutes shall be allowed between cement concrete placements. No cement concrete older than 90 minutes from batch time shall be placed. Procedures for cement concrete placement shall ensure that the cement concrete within the shaft becomes a monolithic, homogeneous unit. The exposed top of concrete shall be cured a minimum of 7 days by covering with wet burlap overlain with plastic sheets. The burlap shall be kept continuously wet during the entire 7 day cement concrete cure period.

B. Tremie Cement Concrete.

Tremies may be used for cement concrete placement in either wet or dry holes. Tremies used to place cement concrete shall consist of a tube of sufficient length, weight, and diameter to discharge cement concrete at the shaft base elevation. The tremie shall not contain aluminum parts that will have contact with the concrete. The tremie inside diameter shall be at least 6 times the maximum size of aggregate used in the cement concrete mix but shall not be less than 200 millimeters (8 inches) for tremie pipe or 100 millimeters (4 inches) for pump hose. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of cement concrete and unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or shear bends that restrict cement concrete placement. An alternate delivery system that can be used in case of failure of the primary delivery system shall be provided.

Tremie cement concrete shall be placed so that mixing with groundwater or slurry is avoided. The tremie tube shall be fitted with a valve or plug to prevent the cement concrete placed initially from contacting water before a sufficient head of concrete has been obtained. The bottom of the tremie tube shall be kept a minimum of 1.52 meters (5 feet) below the top of the in-place concrete at all times once the cement concrete has reached a depth of 1.52 meters (5 feet). The initial placement of the tremie pipe shall be within 305 millimeters (12 inches) from the bottom of the shaft.

The tremie used for wet excavation concrete placement shall be watertight. Underwater placement shall not begin until the tremie is placed to the shaft base elevation. Plugs shall either be removed from the excavation or be of material approved by the Engineer that will not cause a defect in the shaft if not removed. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations.

If concrete is placed under water, all displaced water shall be disposed of in an approved manner. When groundwater, the drilling water or slurry in the shaft excavation is to be removed by pumping during concrete placement, a standby pump shall be kept available on-site.

C. Pumped Cement Concrete.

Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. All pump lines shall have a minimum 100 millimeter (4 inch) diameter and be constructed with watertight joints. Cement concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation.

Cement concrete shall be placed in a continuous operation so that the cement concrete always flows upward within the shaft. The delivery hose or pipe shall be withdrawn slowly as the elevation of the fresh concrete rises in the shaft. The discharge end of the pipe or hose shall be kept at least 1.52 meters (5 feet) below the surface of the cement concrete after the cement concrete has reached a depth of 1.52 meters (5 feet). When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation. During cement concrete placement, markings on the tremie pipe or pump hose or a sounding device or other appropriate method shall be provided and maintained to determine the relative elevations of the fresh cement concrete surface and the bottom end of the pipe or hose.

SECTION 945 (continued)

For wet excavations, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or be of a material, approved by the Engineer, which will not cause a defect in the shaft if not removed.

If for any reason, the tremie/pump line is removed during concrete placement, the line must be resealed at the bottom and once again embedded sufficiently below the level of concrete at which the tremie pipe was removed prior to continuation of the pour. Concrete placement can then be continued until fresh uncontaminated concrete has overflowed the top of the shaft. All contaminated concrete must be removed exposing the clean concrete in the shaft.

D. Free Fall Concrete.

The free fall placement of cement concrete shall only be permitted in dry holes. The maximum height of free fall placement shall not exceed 7.62 meters (25 feet).

Drop chutes shall be used to direct placement of cement concrete to the base of the excavation, where the maximum depth of water shall not exceed 75 millimeters (3 inches), without hitting either the steel reinforcement cage or hole sidewall. Drop chutes shall consist of a smooth tube of either one-piece construction or sections that can be added and removed. Cement concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement. The drop chute shall be supported so that the free fall of the concrete measured from the bottom of the chute is less than 7.62 meters (25 feet) at all times.

If placement cannot be satisfactorily accomplished by free fall in the opinion of the Engineer, the Contractor shall use either tremie or pumping to accomplish the placement of cement concrete.

E. Casing Removal.

If a temporary casing is used during drilled shaft construction, casing removal shall not start until the level of fresh cement concrete within the casing has reached a depth of 3 meters (10 feet).

As the temporary casing is withdrawn, a minimum 1.52 meter (5 feet) head of concrete above the bottom of the casing shall be maintained.

The elevation of the top of the steel reinforcement cage and the elevation of the top surface of the shaft cement concrete shall be checked before and after temporary casing extraction. Any upward or downward movement of the steel reinforcement cage or any large downward movement of the surface of the concrete during casing extraction shall be cause for rejection of the shaft. A slight downward movement of the casing while exerting downward pressure, or hammering or vibrating the casing will be permitted to facilitate extraction. Casing that cannot be extracted during or immediately after the cement concrete placement operation shall also be cause for rejection of the shaft. A repair plan (or a structural evaluation for temporary casing not extracted from the shaft excavation) for all rejected shafts shall be submitted to the Engineer for approval.

The tops of permanent casings shall be removed to the top of the drilled shaft or the finished ground line, whichever is lower, unless otherwise shown or directed. The tops of permanent casings for shafts constructed in a permanent body of water shall be removed to the low water elevation, unless otherwise shown or directed.

945.60 Inspection.

A. General.

Nondestructive Evaluation (NDE) tests shall be performed on all completed drilled shafts as directed by the Engineer. Such tests may include cross-hole acoustic tests, sonic echo tests, and other specified NDE tests.

SECTION 945 (continued)

B. Cross-hole Sonic Testing.

Cross-hole sonic logging (CSL) is a down-hole ultrasonic test method used to evaluate the condition of the concrete within drilled shafts. The test shall meet ASTM D-6760 requirements as modified herein.

This method involves using a piezo-electric transducer (emitter), to generate a signal that propagates as a sound wave (sonic) within the concrete, and another transducer (receiver) is used to detect the signal. Both transducers are placed into a vertical steel pipe filled with water that acts as a coupling medium between the transducer and the tube. These pipes are attached to the reinforcement cage.

The transducers are lowered to the bottom of their respective pipes and placed in the same horizontal plane. The emitter transducer generates a sonic pulse that is detected by the receiver in the opposite pipe. While the pulses are generated, the two transducers are simultaneously raised within the pipes until they reach the top of the drilled shaft. This process is repeated for each possible pipe combination.

The existence of a flaw or defect (void, soil inclusion, or necking within the shaft) will slow down the signal. The signal arrival times are plotted with depth to generate a log for the particular pipe combination. In addition, the energy of each signal (integration of the amplitude with time) is also plotted with depth. Lower energy or longer arrival times would indicate the occurrence and location of the defects.

1. Requirements.

Provisions for sonic testing shall be made for all shafts. The testing subcontractor and test method to be used for sonic testing shall be approved by the Engineer. A record of experience of the testing subcontractor shall be submitted to the Engineer along with written description of the testing procedures, operation manuals for the testing equipment, and samples of previous test results indicating both sound and defective shaft.

2. Installation of Pipes.

The Contractor shall furnish and install a minimum of four 38 millimeter to 50 millimeter (1.5 to 2 inch) internal diameter steel pipes to provide access for sonic testing in each drilled shaft. The pipes shall be installed such that all internal joints are flush.

If the number and placement of the pipes are not called out in the construction drawings, then the following guidelines shall be used:

Shaft Diameter ≤ 1.52 meters (5 feet)	4 Pipes Minimum
1.52 meters (5 feet) < Shaft Diameter ≤ 2.44 meters (8 feet)	6 Pipes Minimum
Shaft Diameter > 2.44 meters (8 feet)	8 Pipes Minimum

The steel pipes shall be connected so that the transducers can pass through unobstructed. The tubes shall be clean from any corrosion or dirt to ensure a good bond between the tube and concrete. The pipes shall be watertight (including at joints) and capped at the bottom and the top. The top cap must be removable (i.e. threaded) for access of the transducers during testing.

The pipes shall be attached to the interior of the reinforcement cage or as specified in the contract documents. However, if the clear spacing between longitudinal bars is less than 125 millimeters (5 inches), the pipes shall be offset from the rebar cage by 75 millimeters (3 inches) toward the center of the shaft. The pipes shall be located in a symmetric pattern depending on the size of the shaft and the number of pipes. Tie wire or spacers shall be used to attach the pipes to the reinforcement cage so that they remain as vertical and parallel as possible during cage installation. The pipes shall extend from 150 millimeters (6 inches) above the bottom of the shaft to 915 millimeters (3 feet) above the top of the shaft, or ground surface, whichever is higher. The pipes shall not be placed on the bottom of the shaft.

The pipes shall be full of clean water prior to cement concrete placement. The caps must be sealed to prevent debris from entering the pipes after the water is placed. The pipes must be handled with care during installation and capping (i.e. no twisting or impacting). After completion of CSL testing and upon approval of the Drilled Shaft by the Engineer, the water shall be removed from the pipes to be completely filled with a cement or sand-cement grout.

SECTION 945 (continued)

3. Sonic Logging Equipment.

The Sonic Logging equipment furnished by the Contractor shall consist of the following components:

- Ultrasonic emitter and receiver probes capable of producing records with good signal amplitude and energy through concrete.
- A measurement wheel or other suitable linear measuring device to record the depth of the transducers.
- A microprocessor based system, with data filtering/amplification and synchronized triggering of records with pulses, that is capable of permanent recording of data, display of individual records, and printing of logs.
- The Contractor shall also furnish all necessary supplies, support equipment, power, and provide reasonable access to the shaft top for performance of the sonic logging.

4. Sonic Logging Test Procedure

Completed drilled shafts shall be tested between 1 and 7 days after placing of cement concrete. Information on the drilled shafts to be provided to the CSL consultant shall include: Shaft bottom and top elevations, pipe lengths and positions, and construction dates including cement concrete placement.

Sonic Logging shall be performed between all possible tube combinations. Tests shall be performed in the same horizontal plane in all pairs of pipes directly across from each other. Tests involving different horizontal planes would be conducted if requested by the Engineer or when necessary to further evaluate defects.

The probes shall be raised simultaneously from the bottom of the pipes by winch ensuring that all slack is taken out of the cables before the analyzer is switched on. The speed of ascent should be less than 305 millimeters (1 foot) per second. A depth wheel or similar measuring device shall be used to provide accurate depth measurements. Measurements shall be taken at 60 millimeter (0.2 feet) intervals or as otherwise directed by the Engineer.

5. Results of Testing.

The Contractor shall provide a CSL Report signed by a Professional Engineer providing the results and recommendations for acceptance or correction of each shaft tested. The report shall include the following:

- The cross-hole sonic logs with potential defects indicated.
- Records of the initial pulse arrival time and energy/amplitude vs. depth for each pipe combination.
- Related interpretation and discussion of the results.

Defects identified by longer arrival times or lower energy signals shall be promptly reported to the Engineer. Any further tests required by the Engineer to evaluate the extent of the defects shall be duly carried out.

6. Acceptance.

Any indicated drilled shaft defects shall require further integrity testing. The Engineer may require other non-destructive tests upon evaluation of the data. These tests may include cross-hole tomography, Single-hole Sonic Logging, Pulse Echo Method, or others.

If the additional tests and records are inconclusive, the Engineer may require coreholes of the defective shaft, at the expense of the Contractor. If the cores show defects in the shaft, these defects shall be repaired at the Contractor's expense by methods acceptable to the Department.

945.61 Drilled Shaft Load Tests.

A. General.

When the contract documents include load testing of shafts, the load test shall be completed before construction of any production drilled shafts. The Contractor shall construct a test shaft in accordance with the provisions of the specifications. The Department's Geotechnical Engineer shall be notified at least 2 working days prior to the start of the load test.

The load test can be performed when 75% of the design compressive strength of the concrete for the drilled shaft is achieved as determined from cylinder breaks. The Contractor shall allow 10 working days for analysis of the load test data by the Engineer before estimated drilled shaft tip elevations are provided for production shafts.

SECTION 945 (continued)

Static load tests shall conform to the requirements of ASTM D1143 (vertical load testing-quick test method) and ASTM D3966 (lateral load testing) or as modified herein.

Other types of Load Tests may be included in a project's Special Provisions. A detailed Testing Plan, in conformance with the specification requirements, shall be submitted to the Engineer for review and approval.

The number and locations of load tests shall be shown on the plans and/or as designated by the Engineer. Unless specified otherwise, the load test shafts shall be loaded to a load equal to 3 times the test shaft design load, or to plunging failure, whichever occurs first. Plunging failure is defined as a deflection of the shaft head equal to 5% of the shaft diameter.

B. Osterberg Cell (O-cell) Load Test.

1. Description.

This work shall consist of furnishing all materials and labor necessary for conducting an Osterberg Cell Load Test and reporting the results of the test. The Osterberg Cell, herein called the O-cell, is a calibrated bi-directional loading device capable of applying loads upward and downward, when embedded in a drilled shaft. The drilled shaft used for the load test shall be instrumented by the Manufacturer of the O-cell as directed by the Engineer.

2. Manufacturer's Representative. The Contractor may obtain the services of a licensed Professional Engineer, with O-cell load testing experience, to conduct the test in compliance with these specifications, record all data and furnish reports of the test results to the Engineer. If so, the Manufacturer's Representative shall be present on site during the initial installation and testing of the shaft.

3. Instrumentation and Materials. The Contractor shall supply all instrumentation and materials required to install the O-cell, conduct the load test and remove the load test instrumentation and apparatus as required. Instrumentation and materials include, but are not limited, to the following:

a. One 1 or more O-Cell with appropriate capacity and diameter for the test shaft.
b. Two 2 circular steel base plates, which shall be 50 millimeters (2 inches) thick and welded to the top and bottom of the cell. Also, a beam or pipe, as required by the manufacturer, to support its placement in the test shaft.
c. High strength pumpable grout with a minimum compressive strength of 30 MPa (4000 psi) at the time of testing. The quantity necessary to place a 25 to 75 millimeter (1 to 3 inch) bed below the bottom of the cell will be required. Type III cement may be substituted upon approval of the Engineer.
d. Materials sufficient to construct a stable reference beam system, for monitoring deflection of the shaft, supported at a minimum distance of 3 shaft diameters from the center of the shaft.
e. Materials sufficient to construct a protected work area (such as a tent or shed for protection from direct sun and inclement weather) of sufficient size to accommodate the entire load test apparatus, instrumentation and personnel performing the test.
f. Electric power, as required for lights, welding, instrumentation, etc.
g. Tell-tale extensometers connected to the upper and lower plates of the O-cell, and strain gages applied in pairs at approved intervals throughout the shaft length. The instrumentation shall be able to provide the distribution of stresses along the shaft length and to distinguish bottom displacement from top displacement of the tested shaft.
h. Clean water from an approved source to mix with a water-soluble oil to be provided by the manufacturer's representative, to form the hydraulic fluid pressure used to pressurize the O-cell.

4. Equipment.

The Contractor shall supply equipment required to install the O-cell, conduct the load test, and remove the load test apparatus. Equipment includes but is not limited to:

a. Welding equipment and certified welding personnel, as required to assemble the test equipment, attach pipes, plates and fittings to the O-cell.
b. A suitable pressurized gas source consisting of either an air compressor or of compressed nitrogen.

SECTION 945 (continued)

c. Equipment and operators for handling the O-cell and piping during the installation of the cell and during the conducting of the test, including but not limited to a crane or other lifting device(s) for the cell piping, manual labor, and hand tools as required by the manufacturer's representative.
d. Equipment and labor sufficient to erect the protected work area and monitoring reference beam system, to be constructed to the requirements of the Engineer and the manufacturer's representative.

5. Procedures.

The O-cell, piping and other attachments will be assembled and made ready for installation under the direction of the manufacturer of the load cell in a suitable area, adjacent to the test shaft, to be provided by the Contractor.

When a reinforcing steel cage is required for the test shaft, the O-cell assembly shall be welded to the bottom of the cage in conjunction with the construction of the cage. If a rebar cage is not required, the load cell and piping shall be supported during installation by suitable means such as two channel beams attached on each side.

When excavation for the test shaft has been completed, inspected, and accepted by the Engineer, a seating layer of concrete or grout shall be placed, by an approved method, at the base of the shaft. The Contractor shall then install the O-cell under the direction of the manufacturer and the Engineer such that the cell is resting firmly in the bed of grout or concrete. The Contractor shall use utmost care in handling the test equipment assembly so as not to damage the instrumentation during installation. Alternatively, the O-cell and its support system can be lowered to near-bottom of the shaft and the center pipe from the cell can be used to grout the space between the cell and the bottom of the shaft so as to firmly seat the cell.

After installation of the cell, the drilled shaft shall be concreted in a manner specified above. However, the Contractor may use high early cement (Type III) in the mix to reduce the time between concreting and testing, when approved by the Engineer.

The load sequence shall be as follows:

a. Apply 5% of the anticipated ultimate capacity of the test shaft, in load increments at 5-minute intervals until the maximum capacity of the cell is reached or until the shaft has failed as determined by the Engineer.
b. At the maximum load or failure load (as determined by the Engineer), maintain the load for a minimum of ½ hour.
c. Remove the load in 10% load increments at 5-minute intervals until zero load is reached.
d. At each load increment, or decrement, movement indicators shall be read at a minimum of 1, 2 and 4-minute intervals while the load is held constant.

During the period required to perform the load test, no drilling or excavation operations on any shaft may be performed. If test apparatus show signs of negative effects due to other construction activities, such activities shall be halted for the duration of the test. After completion of the load test the contractor shall remove any equipment, material, waste, etc., which are not to be part of the finished structure.

6. Report. The contractor will supply 3 copies of a report for each load test detailing the load-movement curves and test data. The report shall be reviewed and approved by the Geotechnical Engineer.

945.62 Defective Drilled Shafts.

Defective drilled shafts are defined as exhibiting flaws that result in inadequate performance (deflections criteria) or unsafe performance (capacities criteria) under the shaft design loads, as determined by the Engineer, based on the shaft construction records, NDE, and load test data.

The Contractor shall submit a plan for remedial action to the Engineer for acceptance. Modifications to the structural integrity and/or load transfer mechanism caused by the remedial action shall require that calculations and working drawings stamped by a Professional Engineer registered in the Commonwealth of Massachusetts for all elements affected, be provided. All labor and materials necessary to complete the remedial work shall be furnished without cost to the Department.

SECTION 945 (continued)

945.80 Method of Measurement.

Drilled shaft excavation will be measured for payment on a length basis by the meter (linear foot) of completed drilled shaft excavation of the diameter shown on the plans measured along the centerline of the shaft from the bottom to the top of the completed shaft excavation or to the mud line if under water, less the measured length of obstruction excavation and less the measured length of rock socket excavation. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Rock socket excavation will be measured for payment on a length basis by the meter (linear foot) of completed rock socket excavation of the diameter shown on the plans measured from the highest point of encountered rock within the rock socket to the bottom of rock socket. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Obstruction excavation, after designation as obstruction excavation by the Engineer, will be measured for payment on a length basis by the meter (linear foot) of completed obstruction excavation of the shaft diameter indicated on the plans. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Trial drilled shafts that are accepted, including backfill when required, will be measured for payment by the meter (linear foot) of completed trial drilled shaft of the diameter shown on the plans measured along the centerline of the trial shaft from the bottom of completed trial shaft to the top of the completed trial shaft or to the mud line if under water. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Drilled shafts, of the cement concrete and steel reinforcement as shown on the plans, will be measured for payment on a length basis by the meter (linear foot) of completed drilled shaft of the diameter shown on the plans measured along the centerline of the shaft from the bottom of the rock socket or shaft excavation to the top of the completed shaft or to the mud line if under water. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Permanent casing will be measured for payment on a length basis by the meter (linear foot) of permanent casing of the diameter shown on the plans measured along the centerline of the shaft from the bottom to the top of the permanent casing. Measurement shall be to the nearest 1/10 of a meter (linear foot).

Cross-hole sonic logging (CSL) access pipes will be measured on a length basis by the number of meters (feet) of pipes installed and grouted (upon acceptance of testing) regardless of whether sonic testing is performed.

Cross-hole sonic logging (CSL) sonic testing shall be measured on an each basis per shaft tested.

Osterberg load cell axial load testing shall be measured on an each basis per shaft tested.

Conventional axial load testing shall be measured on an each basis per shaft tested.

945.81 Basis of Payment.

Drilled shaft excavation will be paid at the contract unit price per meter (linear foot) of completed drilled shaft excavation of the diameter shown on the plans. Payment for drilled shaft excavation shall be considered complete compensation for temporary casing, water control, removal from the site and disposal of excavated materials, using slurry as necessary, tools and drilling equipment to excavate the shaft, and furnishing all other labor, materials and equipment necessary to complete the drilled shaft excavation. If larger diameter drilled shaft excavation than that specified on the plans is performed at the Contractor's option, no additional compensation will be provided to perform this oversized drilled shaft excavation.

Rock socket excavation will be paid at the contract unit price per meter (linear foot) of completed rock socket excavation of the diameter shown on the plans. Payment for rock socket excavation shall be considered full compensation for water control, removal from the site and disposal of excavated materials, drilling equipment, procedures to excavate the rock socket to the required depths, and all labor, materials, equipment, and tools necessary to complete the rock socket excavation. If larger diameter rock socket excavation than that specified on the plans is performed at the Contractor's option, no additional compensation will be provided to perform this oversized rock socket excavation.

SECTION 945 (continued)

Obstruction excavation, after designation as obstruction excavation by the Engineer, will be paid at the contract unit price per meter (linear foot) of completed obstruction excavation of the shaft diameter indicated on the plans. Payment for obstruction excavation shall be considered full compensation for water control, removal from the site and disposal of excavated materials, drilling equipment, procedures to excavate the obstruction to the required depths, and all labor, materials, equipment, and tools necessary to complete the obstruction excavation. If larger diameter obstruction excavation than that specified on the plans is performed at the Contractor's option, no additional compensation will be provided to perform this oversized obstruction excavation.

Trial drilled shafts that are accepted will be paid at the contract unit price per meter (linear foot) of completed trial drilled shaft of the diameter shown on the plans. Payment for trial drilled shafts shall be considered full compensation for the excavation of the trial shaft hole through whatever materials are encountered to the authorized bottom of trial shaft, including obstructions, temporary casings, backfilling the hole with unreinforced concrete, restoring the site as required, and all other incidentals necessary to complete the trial drilled shaft. If larger diameter trial drilled shaft than that specified on the plans is performed at the Contractor's option, no additional compensation will be provided to perform this oversized trial drilled shaft.

Drilled shafts, of the diameter, cement concrete and steel reinforcement as shown on the plans, will be paid at the contract unit price per meter (linear foot) of completed drilled shaft. Payment for drilled shafts shall be considered full compensation for all cement concrete, steel reinforcement, labor, materials, equipment, and all other incidentals necessary to complete the drilled shaft. This payment shall include all cement concrete and steel reinforcement that extends into rock sockets, if any, and all steel reinforcement that is embedded in the shaft and extends above the top of the shaft to the point where it connects to any steel reinforcement that is not embedded in the drilled shaft. Bracing, centering devices, and support devices for the steel reinforcement cage shall be considered incidental to the work. If a larger diameter drilled shaft than that specified on the plans is constructed at the Contractor's option, no additional compensation will be provided to perform this oversized drilled shaft construction.

Permanent casing shall be paid at the contract unit price per meter (linear foot) of permanent casing of the diameter shown on the plans furnished and installed in the drilled shafts. Payment for permanent casing shall be considered full compensation for all labor, materials, equipment, and all other incidentals necessary to complete the permanent casing.

Cross-hole sonic logging (CSL) access pipes shall be paid at the contract unit price per meter (linear foot) of access pipe installed. Payment for cross-hole sonic logging (CSL) access pipes shall be considered full compensation for the supply and installation of the pipe and the grouting of the pipes after testing.

Cross-hole sonic logging (CSL) sonic testing shall be paid at the contract unit price per shaft tested. No payment shall be made for supplementary sonic logging testing required to further evaluate any shaft defects detected by the initial cross-hole sonic logging (CSL) sonic test. Payment for cross-hole sonic logging (CSL) sonic testing shall be considered full compensation for the performance of the test, including all labor, equipment, and materials incidental to the test instrumentation, data collection, and report.

Osterberg load cell axial load testing shall be paid for at the contract unit price per each Osterberg load cell axial load test completed and accepted. Payment for Osterberg load cell axial load testing shall be considered full compensation for the performance of the load test, including all labor, equipment, and materials incidental to the test instrumentation, data collection and report (and subsequent removal of test apparatus and appurtenances) prepared under the direction of the Engineer and the manufacturer's representative.

Conventional axial load testing shall be measured on an each basis per shaft tested.

SECTION 945 (continued)

945.82 Payment Items.

945.1*	Drilled Shaft Excavation * Millimeter Diameter	Meter
945.2*	Rock Socket Excavation * Millimeter Diameter	Meter
945.3*	Obstruction Excavation * Millimeter Diameter	Meter
945.4*	Trial Shaft * Millimeter Diameter	Meter
945.5*	Drilled Shaft * Millimeter Diameter	Meter
945.6*	Permanent Casing * Millimeter Diameter	Meter
945.71	Cross Hole Sonic Testing Access Pipes	Meter
945.72	Cross Hole Sonic Test	Each
945.81	Osterberg Load Cell Axial Load Test	Each
945.82	Conventional Axial Load Test	Each

945.1*	Drilled Shaft Excavation * Feet Diameter	Linear Foot
945.2*	Rock Socket Excavation * Feet Diameter	Linear Foot
945.3*	Obstruction Excavation * Feet Diameter	Linear Foot
945.4*	Trial Shaft * Feet Diameter	Linear Foot
945.5*	Drilled Shaft * Feet Diameter	Linear Foot
945.6*	Permanent Casing * Feet Diameter	Linear Foot
945.71	Cross Hole Sonic Testing Access Pipes	Linear Foot
945.72	Cross Hole Sonic Test	Each
945.81	Osterberg Load Cell Axial Load Test	Each
945.82	Conventional Axial Load Test	Each

* = as per MHD Standard Nomenclature

DIVISION III
MATERIALS SPECIFICATIONS

SECTION M1
SOILS AND BORROW MATERIALS

SUBSECTION M1.03.0 Gravel Borrow.
(page III.4) Add the following below M1.03 Type c:

M1.03 Type d	37.5 millimeters largest dimension

SECTION M3
BITUMINOUS MATERIALS

SUBSECTION M.3.11.03 Job Mix Formula.
(page III.17) Replace the 2nd paragraph with the following:

The use of Reclaimed Asphalt Pavement, RAP, will be permitted at the option of the Contractor and provided that the end product is in conformance with the designated job-mix formula. The proportion of RAP to virgin aggregate shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for surface courses shall be 10%. Reclaimed Asphalt Pavement will not be allowed in Open Graded Friction Course (OGFC).

(page III.19) Replace notes a) through f) with the following:

a) A polymer additive consisting of unvulcanized Styrene Butadiene Rubber (SBR) in liquid latex form, with a total rubber solids content percentage by weight of 60-72, shall be added.

The quantity of rubber solids shall be 3% by weight of the bitumen content of the mix. If the latex polymer is 70% solids, weight per liter is 0.96 kg = 0.67 kg solids per liter. If mix calls for 6% bitumen, 3% = 1.8 kg of latex solids per Megagram of mix or 2.67 liters of latex per Megagram of mix.

The polymer modifier (latex) is injected into the mix at the time of manufacture. In a drum plant, the polymer is pumped into the asphalt binder through a spud welded to the asphalt binder line just prior to where it enters the drum. The constant rate at which the polymer is pumped is determined by the mix speed of the drum. In a batch plant, the amount of polymer per batch is determined by the size of the batch and is introduced as follows: A feed hose from the polymer pump is inserted into and above the mixer or pug mill and the polymer is pumped directly into the mix 5 seconds after the asphalt binder starts to dump into the pug mill. Mix time per batch after polymer is pumped in is 45 to 60 seconds.

The manufacturer will have a professional representative available at the asphalt plant during the first day of mix production and placement, and as required thereafter by the Engineer.

The manufacturer of the SBR latex shall provide certified test results for Styrene Butadiene ratio, total rubber solids percentage by weight, pH, ash content, and viscosity to the Engineer prior to mix production.

b) Mixing temperatures for OGFC shall be between 143 and 163◦C. This will require close control over aggregate drying and asphalt storage temperatures so that the resulting mix temperatures will fall within the limits stipulated herein.

c) Placing temperature for OGFC shall be between 135 and 155◦C. As placing temperature is a critical factor in this type of mix, hauling time to the project should be limited so as to avoid mix temperature from dropping below the required minimum. All mixes should be covered during transportation.

d) Tack coat – *Asphalt Emulsion,* RS-1 when needed, applied at the rate of 0.25 liters per square meter.

SUBSECTION M3.11.03 (continued)

e) Silicone shall be added as the anti-stripping additive to the asphalt in the amount of 1.5 grams per cubic meter of asphalt.

f) Mix meeting the requirements of this specification shall be placed to a compacted thickness of 25 millimeters for OGFC.

SUBSECTION M.3.11.07 Plant Requirements.

(page III.23) Under Requirements for Batch Plants, G. Preparation of Mixtures, 3. Preparation of Hot Mix Asphalt Mixture., last paragraph, change 190°C to 163°C.

SECTION M4
CEMENT AND CEMENT CONCRETE MATERIALS

SUBSECTION M4.02.00 Cement Concrete.

(page III.29) Add the following sentence to the end of the first paragraph of the page:

Concrete that is used to construct drilled shafts shall have an entrained air content of 4.0% ± 1.0%.

SUBSECTION M4.02.06 Proportioning.

*(page III.33) Under **2. Consistency.** replace the general requirements in regard to consistency with the following:*

Mass Concrete	50 ± 13 mm slump
Exposed Bridge Deck Concrete	63 ± 13 mm slump
Reinforced Concrete	75 ± 25 mm slump
Very Constricted Placement Conditions	100 ± 25 mm slump
Pump Concrete	100 ± 25 mm slump
Tremie Concrete	150 ± 25 mm slump
Drilled Shaft Concrete (Permanent Casing or Dry Uncased Placement)	125 ± 25 mm slump
Drilled Shaft Concrete (Dry Temporary Casing Placement)	175 ± 25 mm slump
Drilled Shaft Concrete (Tremie or Slurry Placement)	200 ± 25 mm slump

SUBSECTION M4.02.12 Cold Weather Concrete.

(page III.38) Delete this Subsection.

SUBSECTION M4.02.14 Precast Units.

(page III.39) Under C. Vibration, change 901.65C to 901.63C.

SUBSECTION M4.06.1 HP Cement Concrete.
(page III.48) Add this new Subsection:

M4.06.1 High Performance Cement Concrete.

High Performance (HP) Cement Concrete shall meet the requirements of M4.02.00 in the classifications listed below and shall be modified by the addition of silica fume, calcium nitrite, and an admixture of either fly ash or ground granulated blast-furnace slag or a combination of fly ash and ground granulated blast-furnace (GGBF) slag. The Contractor may elect to use fly ash, GGBF slag, or a combination thereof provided that the permeability and strength provisions contained herein are satisfied and the Research and Materials Division has approved the trial batches and mix design. Changing the mix design shall not be accepted and approved by the Research and Materials Division without the preparing, testing, and approval of trial batches for the revised mix design.

28 Day Compressive Strength (psi)	Maximum Coarse Aggregate Size (inches)	Total Cementitious Content (lb/cy)
5000	¾	685
5000	3/8	710

28 Day Compressive Strength (MPa)	Maximum Coarse Aggregate Size (mm)	Total Cementitious Content (kg/m^3)
35	20	405
35	10	425

The concrete placed shall be air entrained (7 ± 1%) High Performance Cement Concrete with a target slump of 100 millimeters (4 inches). The permitted slump range shall be 50 millimeters to 150 millimeters (2 inches to 6 inches), except for concrete to be pumped, which shall have a permitted slump range of 75 millimeters to 150 millimeters (3 inches to 6 inches). Silica fume shall constitute of 6% ± 1% (dry weight) of the cementitious content. Fly ash, if used instead of GGBF slag, shall constitute 15% (dry weight) of the cementitious content. GGBF slag, if used instead of fly ash, shall constitute 25% (minimum dry weight) to 40% (maximum dry rate) of the cementitious content. Combinations of fly ash and GGBF slag may be used provided that the permeability and strength provisions contained herein are satisfied and the Research and Materials Division has approved the mix design and approved the trial batches. The trial batches must have used GGBF slag and/or fly ash addition rates that are consistent with the mix design's addition rates. The water-cementitious ratio shall be 0.40 maximum. The cementitious content shall be the sum of the Portland cement, silica fume, fly ash, ground granulated blast-furnace slag, and all other approved pozzolanic admixtures. The water content of all additives shall be included in the water-cementitious ratio.

Calcium nitrite corrosion inhibitors shall conform to AASHTO M 194. MassHighway Research and Materials Division must approve the material. Acceptance will depend upon the material's conformance, as documented by certified test results, to all applicable sections of AASHTO M 194. The calcium nitrite solution shall contain 30% $\pm$ 2% calcium nitrite by weight. The calcium nitrite material shall have neutral set characteristics.

The calcium nitrite shall be added at a rate of 15 liters per cubic meter (3 gallons per cubic yard) of concrete in order to increase the active corrosion threshold to 5.9 kilograms of chloride per cubic meter (9.9 pounds of chloride per cubic yard) of concrete at the reinforcing bar level.

Fly ash shall conform to AASHTO M 295, Type F.

Ground granulated blast-furnace slag shall be Grade 100 and/or Grade 120 and shall conform to AASHTO M 302.

SUBSECTION M4.06.1 (continued)

Silica fume shall conform to AASHTO M 307. Pre-blended silica fume cement meeting both AASHTO M 307 and AASHTO M 240 Blended Hydraulic Cement may be used for producing Silica Fume Modified Concrete provided that the overall amount of silica fume is 6% ± 1% (dry weight) of the cementitious content. If pre-blended silica fume cement is proposed for use, the Contractor shall provide certificates from the manufacturer which certify that the silica fume meets the requirements of AASHTO M 307. The Contractor shall obtain a written statement from the manufacturer of the silica fume that it is compatible with the other materials from the sources proposed by the Contractor along with mill analysis test certification demonstrating conformance to the referenced specifications.

The HP Cement Concrete shall be mixed for a minimum of 20 minutes at mixing speed for a minimum total of 120 revolutions to ensure proper dispersion of the admixtures. The mix shall contain superplasticizer conforming to AASHTO M 194 Type F or G, which shall be added in accordance with the concrete technician's recommendations. The amount of superplasticizer added to the cement concrete at the batching facility and at the job site shall be recorded on the delivery slip. The delivery slip shall be signed by the concrete technician. The concrete technician shall be supplied by the silica fume manufacturer and be either an ACI Certified Concrete Technician (minimum Grade I - Field) or a New England Transportation Technician Certification Program - Certified Concrete Technician.

Trial batch testing will be performed on samples of the same contents and proportions as the HP Cement Concrete to be used in the proposed structures. Trial batches shall be prepared using representative concrete at a 150 millimeter (6 inch) maximum slump. Coulomb tests shall be made on two 100 millimeter X 200 millimeter (4 inch X 8 inch) representative samples that do not contain calcium nitrite and have been moist cured for a maximum of 90 days. Coulomb tests on trial batches shall be performed as early as possible during the construction season in order that the approval process does not delay the anticipated date of HP Cement Concrete placement. An independent AASHTO accredited laboratory shall perform the Coulomb testing. If test results exceed a maximum of 1500 coulombs, the Contractor, at his expense, shall adjust the mix and resubmit trial batches until a trial batch passes the coulomb test.

Prior to concrete placement, the Contractor shall develop and forward a copy of the HP Cement Concrete design mix to the Department for review and approval. Approval of the design mix must be obtained prior to placement of concrete. The mix design sent to the Department must be accompanied with trial batch information. Trial batches shall be performed in accordance with procedures outlined by the Department. The Contractor shall have technical representatives from the silica fume supplier and the ready mix producer at the job site during placement of the concrete. The concrete technicians shall each meet the certification requirements as referenced previously in this section. The Contractor will assume these costs.

Appropriate retarders and high range water reducers shall be used as recommended by the ACI certified concrete representative to ensure that potential for the formation of temperature induced plastic shrinkage cracking is minimized.

SUBSECTION M4.07.0 Latex Modified Mortar and Concrete Overlayments.
(page III.48) Delete this Subsection.

SECTION M5
PIPE, CULVERT SECTIONS AND CONDUIT

SUBSECTION M5.03.10 Corrugated Plastic Pipe.
(page III.57) Replace this Subsection with the following:

Pipe shall consist of corrugated polyethylene tubing, flare ends, couplings and fittings. Materials, dimensions, physical properties and fabrication shall be in accordance with AASHTO M 294, type S or Sp as applicable.

Pipe used for drainage pipe shall have a smooth interior and shall have an inside diameter of 305, 380, 455, 535, 610, 760, or 915 millimeters.

SECTION M8
METALS AND RELATED MATERIALS

SUBSECTION M8.05.8 Steel Casing.
(page III.75) Add this new Subsection:

This specification covers cylindrical steel casings of uniform cross section and diameter throughout its length in which the cylindrical casing acts as either a temporary or permanent load-carrying member.

Permanent steel casings shall conform to the requirements of ASTM A 252. Temporary casings shall be of a grade selected by the Contractor. Temporary casings that are used and are in good condition without strength impairing defects are acceptable for use as temporary casings. Permanent casings shall not have been previously used. Temporary casings that are left in place and connected to permanent casings shall meet the requirements of permanent casings.

Casings having seams of spiral-lap welded construction will not be permitted for use as permanent steel casings.

The outside diameter and wall thickness of the permanent steel casings shall be as shown on the plans. When permanent casings are used to carry part of the design load, all joints shall have full-penetration welds. All welds shall be inspected using ultrasonic testing. Any attachment between permanent and temporary casings shall be welded with full penetration welds using an approved backing ring, which shall develop the full strength of the casings in compression and bending.

Temporary casings shall be the responsibility of the Contractor and shall be of sufficient strength to resist the handling, transportation, installation, and external stresses of the subsurface materials.

SUBSECTION M.8.13.3 Aluminum Handrail and Protective Screen Type I and Type II.
(page SUPPLEMENT2002-109) Change the reference in paragraph C from ASTM B221 to ASTM B211.

SUBSECTION M8.22.0 Cross Hole Sonic Testing Access Pipes.
(page III.85) Add this new Subsection:

Steel pipe for cross hole sonic testing access pipes shall be Schedule 40 and shall conform to ASTM A 53, Grade B.

SECTION M9
MISCELLANEOUS MATERIALS

SUBSECTION M9.06.4 Polyethylene Coated Burlap.
(page III.93) Replace this subsection with the following:

The material shall conform to the requirements of AASHTO M171, Sheet Materials for Curing Concrete.

SUBSECTION M9.40.0 Drilling Slurry.
(page III.98) Add this new Subsection:

Drilling slurry shall conform to one of the following specifications. Reports of all required tests shall be furnished to the Engineer upon completion of each drilled shaft.

Mineral Slurry.

Mineral slurry shall be premixed thoroughly with water and adequate time, as prescribed by the manufacturer, shall be allotted for hydration prior to introduction into the shaft hole. Slurry tanks of adequate capacity are required for slurry circulation, storage, and treatment. Control tests shall be performed on the mineral slurry by the Contractor to determine density, viscosity, sand content and pH. Properties of mineral slurry (Bentonite or Attapulgite) in water shall meet the following range of values:

Property	Value Required	Test Method
Density (Unit Weight)*	1030-1200 kg/m^3 (64-75 lb/ft^3)	Mud Density API 13B-1 Section 1
Viscosity	27.5-53 sec/L (26-50 sec/qt)	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	8-11	Glass Electrode, pH Meter, or pH Paper
Sand Content	4.0% by volume maximum	Sand Content API 13B-1 Section 5

* To be increased by 32 kg/m^3 (2 lb/ft^3) in salt water or brackish water.

Tests to determine density, viscosity and pH shall be performed during shaft excavation to establish a consistent working pattern. Four sets of tests shall be made during the first 8 hours of slurry use. When the results show consistent behavior, one set of testing shall be made every 4 hours of slurry use thereafter.

Water Slurry.

The use of water slurry without full length steel casings will only be allowed if approved in writing by the Engineer. In that case, all of the properties of mineral slurry shall be met, except that the maximum density shall not exceed 1120 kg/m^3 (70 lb/ft^3). Mixtures of water and on-site soils shall not be allowed for use as a drilling slurry, since particulate matter falls out of suspension easily and can contaminate the concrete.

Polymer slurry.

Natural or synthetic slurry shall have specific properties at the time of mixing and of concreting that are in conformance with the written recommendations of the manufacturer and the Contractor's Drilled Shaft Installation Plan. The Contractor shall perform the required tests at the specified frequency and shall provide slurry that complies with the maximum and/or minimum property requirements for the subsurface conditions at the site and with the construction methods that are used. Whatever product is used, the sand content at the base of the shaft excavation shall not exceed 1 % when measured by the API sand content test, immediately prior to concreting.

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END OF STANDARD SPECIAL PROVISIONS